SCATTERING AND TRANSMISSION CHARACTERISTICS OF WAVES IN COMPOSITE-MATERIAL-EMBEDDED CYLINDRICAL LAYERED MEDIA

徐春傳、許崇宜，邱政男

E-mail: 9113826@mail.dyu.edu.tw

ABSTRACT

THE PURPOSE OF THIS THESIS IS TO INVESTIGATE THE ELECTROMAGNETIC PROPAGATION CHARACTERISTICS, INCLUDING SHIELDING AND SCATTERING, ASSOCIATED WITH COMPOSITE-MATERIAL-EMBEDDED CYLINDRICAL LAYERED MEDIA. ON THE BASIS OF A BULK MODEL, EACH SHELL OF THE LAMINATED COMPOSITE MATERIAL IS REGARDED AS HOMOGENEOUS, AND IS CHARACTERIZED BY COMPLEX PERMITTIVITY AND PERMEABILITY TENSORS TO ACCOUNT FOR THE LOSSY AND ANISOTROPIC NATURE OF THE MEDIUM. THE FIELDS INSIDE THE COMPOSITE MATERIALS ARE EXPRESSED AS AN INFINITE SERIES WITH THEIR COEFFICIENTS SOLVED BY USING FINITE-DIFFERENCE APPROACH ALONG THE RADIAL DIRECTION, WHEREAS THE FIELDS IN EACH ISOTROPIC LAYERED MEDIA ARE EXPANDED IN TERMS OF EIGENFUNCTIONS. BY ENFORCING THE BOUNDARY CONDITIONS, ONE OBTAINS ALL THE UNKNOWN COEFFICIENTS FROM WHICH THE SHIELDING EFFECTIVENESS AND THE RADAR ECHO WIDTH CAN BE READILY COMPUTED. COMPOSITE MATERIALS, INCLUDING GRAPHITE/EPOXY (G/E) AND BORON/EPOXY (B/E) FIBER-REINFORCED LAMINATED COMPOSITES, HAVE BEEN CONSIDERED IN THIS STUDY. THE EFFECTS OF VARIOUS PARAMETERS, SUCH AS THE ORIENTATION AND CONDUCTIVITY OF THE FIBER, THE THICKNESS OF THE LAMINATE, THE DIELECTRIC CONSTANT OF THE MATRIX MATERIAL, AND THE POLARIZATION OF THE INCIDENT WAVE, ON THE PROPAGATION CHARACTERISTICS ARE ALL THOROUGHLY STUDIED.

Keywords : COMPOSITE MATERIALS, PROPAGATION CHARACTERISTICS, ELECTROMAGNETIC SHIELDING PROPERTIES, TRANSMISSION PROPERTIES.

Table of Contents

REFERENCES

[1]B. C. HOSKIN AND A. A. BAKER. COMPOSITE MATERIALS FOR AIRCRAFT STRUCTURES, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, INC., 1985.

[2]J. E. BRIDGES, "AN UPDATE ON THE CIRCUIT APPROACH TO CALCULATE SHIELDING EFFECT IVENESS, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 30, NO. 3, PP. 211-221, AUG. 1988.

[3]S. A. SCHELKUNOFF, ELECTROMAGNETIC WAVES, PRINCETON, NJ: D. VAN, NOSTRAND, 1943, PP. 303-315.

[4]R. B. SCHULZ, G. C. HUANG, AND W. L. WILLIAMS, "RF SHIELDING DESIGN, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. EMC-10, PP. 168-175, MAR. 1968.

[5]R. B. SCHULZ, SHIELDING IN PRACTICAL DESIGN FOR ELECTROMAGNETIC COMPATIBILITY, R. F. FICCHI, ED. NEW YORK: HAYDEN, 1971, PP. 69-92.

[6]R. B. SCHULZ, V. C. PLANTZ, AND D. R. BRUSH, "SHIELDING THEORY AND PRACTICE, " IEEE. TRANS. ELECTROMAGN. COMPAT., VOL. 30, NO.3, PP. 187-201, AUG. 1988.

[7]H. WHEELER, "THE SPHERICAL COIL AS INDUCTOR, SHIELD, OR ANTENNA, " PROC. IRE, PP. 1595-1602, 1958.

[8]F. A. M. RIZK, "LOW-FREQUENCY SHIELDING EFFECTIVENESS OF A DOUBLE CYLINDER ENCLOSURE, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. EMC-19, PP. 14-21, FEB. 1977.

[9]S. SHENFELD, "SHIELDING OF CYLINDRICAL TUBES, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. EMC-10, PP. 29-34, MAR. 1968.
[10]CHEN-NAN CHIU AND CHUN HSIUNG CHEN, "PLANE-WAVE SHIELDING PROPERTIES OF ANISOTROPIC LAMINATED COMPOSITE CYLINDRICAL SHELLS, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 37, NO.1, PP. 109-113, FEB. 1995.
[11]M. S. LIN AND C. H. CHEN, "PLANE-WAVE SHIELDING CHARACTERISTICS OF ANISOTROPIC LAM -INATED COMPOSITES, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 35, PP. 21-27, FEB. 1993.
[12]M. S. LIN, C. M. LIN, R. B. WU, AND C. H. CHEN, "TRANSIENT PROPAGATION IN ANISOTROPIC LAMINATED COMPOSITES, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 35, PP. 357-365, AUG.1993.
[13]M. S. LIN, R. B. WU, AND C. H. CHEN, "TIME-DOMAIN ANALYSIS OF PROPAGATION IN INHOM -OGENEOUS ANISOTROPIC LOSSY SLABS, " IEEE TRANS. ANTENNAS PROPAGAT., VOL. 41, PP.1456-1459, OCT. 1993.
[14]C. N. CHIU AND C. H. CHEN, "SCATTERING FROM AN ADVANCED COMPOSITE CYLINDRICAL SHELL, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 38, PP. 62-67, FEB. 1996.
[15]H. C. CHU, S. K. JENG, AND C. H. CHEN, "REFLECTION AND TRANSMISS- ION CHARACTERISTICS OF LOSSY PERIODIC COMPOSITE STRUCTURES, " IEEE TRANS. ANTENNAS PROPAGAT., VOL. 44, PP. 580-587, APR. 1996.
[16]H. C. CHU, S. K. JENG, AND C. H. CHEN, "REFLECTION AND TRANSMISS- ION CHARACTERISTICS OF SINGLE-LAYER PERIODIC COMPOSITE STRUCTURES FOR TE CASE, " IEEE TRANS. ANTENNAS PROPAGAT., VOL. 45, JULY.1997.
[17]H. C. CHU AND C. H. CHEN, "SHIELDING AND REFLECTION PROPERTIES OF PERIODIC FIBER-MATRIX COMPOSITE STRUCTURES, " IEEE TRANS. ELECTROMAGN. COMPAT., VOL. 38, PP. 1-6, FEB. 1996.
[18]C. D. SKOUBY, "EFFECTS OF ADVANCED COMPOSITES ON SHIELDING AND ANTENNA PERFORMANCE, " IEEE INT. SYMP. ELECTROMAGN. COMPAT., WASHINGTON, DC, 1976, PP. 192-197.
[19]W. C. CHEW, WAVES AND FIELD IN INHOMOGENEOUS MEDIA, NEW YORK: VAN NOSTRAND REINHOLD, 1990. CH.2, PP. 131-133.
[20]G. LUBIN, HANDBOOK OF COMPOSITES, VAN NOSTRAND REINHOLD COMPSNY INC., 1982.
[21]J. R. VINSON AND R. L. SIERAKOWSKI, THE BEHAVIOR OF STRUCTURES COMPOSED OF COMPOSITE MATERIALS, MARTINUS NIJHOFF PUBISHERS, DORDRECHT, CH.1, 1986.
[22]K. K. CHAWLA, COMPOSITE MATERIALS-SCIENCE AND ENGINEERING, SPRINGER-VERLAG, NEW YORK INC., 1987.
[23]W. C. CHEW, WAVES AND FIELD IN INHOMOGENEOUS MEDIA, NEW YORK: VAN NOSTRAND REINHOLD, 1990. CH.3, PP. 162-171.
[24]C. N. CHIU, M. S. LIN, AND C. H. CHEN, "LOW-FREQUENCY MAGNETIC FIELD ATTENUATION OF ADVANCED COMPOSITE CYLINDERS, "IEEE INT. SYMP. ELECTROMAGN. COMPAT., "DALLAS, PP. 164-167, 1993.